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THE BASAL METABOLISM OF INFANTS FED ON DRY MILK POWDER.

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This report is part of an investigation on the use of dry milk powder in infant feeding made by the United States Public Health Service. A preliminary report made by Surg. W. H. Price appeared in Public Health reports, April 2, 1920.¹

The present study on the basal metabolism of 13 normal infants fed on dry milk powder was conducted at the Massachusetts General Hospital, and it was through the helpful cooperation of Miss Helen Falvey, temporary supervising nurse, United States Public Health Service, and the Baby Hygiene Association of Boston, that this part of the investigation was made possible.

The clinical status of the babies studied was obtained from their records at the Baby Hygiene Association. The babies were also given a superficial physical examination on the day that the metabolism was determined. In general, it may be said that they were satisfied with their food, were gaining weight, and had well-digested stools. As in the cases reported by Surg. Price, group 2 received 164 grams (equivalent to $1\frac{1}{2}$ cupfuls) of whole dry milk powder to 1 quart of boiled water, giving approximately the following: Fat 4 per cent, sugar 5.7 per cent, and protein 3.71 per cent. Group 3 received reconstructed, or emulsified, milk made from dry skim milk powder, unsalted butter fat, and water emulsified in a centrifugal apparatus. The constituents of the reconstructed milk were, approximately, fat 4 per cent, sugar 5.1 per cent, and protein 3.1 per cent.

The technique of investigation was the same as that used by Benedict and Talbot in previous investigations on infant metabolism. (See publications of the Carnegie Institution of Washington, 201, 233, and 302.) The infants were brought to the Massachusetts General Hospital in the morning. They were fed immediately before they entered the respiration chamber to find out the effect, if any, of the dry milk powder on the basal metabolism and compared with normal infants fed at the breast or bottle fed with ordinary milk dilutions.

The following is a summary of the histories, showing the clinical status of the infants.

SUMMARY OF CASE HISTORIES.

CASE 1: A. P., a male infant 9 months old. Full term, normal labor, birth weight unknown. Always bottle fed and had done well. When 3 months old weighed 4.025 kilos, and was put on a mixture of whole dry milk powder, water, and malt sugar. Four months later weighed 7.2 kilos. At time of experiment, when 9 months old,

¹ *Dried Milk Powder in Infant Feeding.* Reprint No. 588.

weighed 7.944 kilos, had 7 teeth, stools were normal. In addition to the dry milk mixture, he was receiving orange juice. Rectal temperature on day of metabolism experiment, $99\frac{2}{5}^{\circ}$ and 100° F.

Summary.—A normal infant, close to expected weight of 8.39 kilos for age.

CASE 2: M. F., a female infant, $5\frac{1}{2}$ months old. Full term, normal labor, birth weight unknown. Breast fed for two weeks and then put on whole milk and maltose. On this mixture she had much gas and slight eczema of face. When $3\frac{1}{2}$ months old weighed 6.35 kilos, and was put on a whole dry milk powder, and is recorded as having improved steadily. When seen at $5\frac{1}{2}$ months of age weighed 7.895 kilos, was bright, happy, and well proportioned, with firm flesh. She had been receiving orange juice since birth. At the time of metabolism experiment she was receiving whole dry milk powder $6\frac{1}{2}$ ounces, boiled water 48 ounces; 6 ounces every three hours.

Summary.—A well, healthy infant, weighing 845 grams more than the expected weight of 7.05 kilos.

CASE 3: R. S., a male infant, $9\frac{3}{4}$ months old. Full term, normal labor, breast fed during the first three months. When weaned, was put on a whole milk and maltose mixture, but did not do well. At 4 months of age was given a whole dry milk mixture and improved steadily; bowels regular, stools normal. He was receiving orange juice daily. No teeth. When metabolism was determined, he was receiving whole dry milk powder 6 ounces, water 32 ounces.

Summary.—An average, normal infant, weighing 8.675 kilos. Expected weight 8.66 kilos.

CASE 4: M. H., female infant, $8\frac{1}{2}$ months old. Premature birth; said to have weighed less than 0.9 kilo. Never breast fed. Until $2\frac{1}{2}$ months of age was on a whole milk formula and gained very slowly. Since then on a dry milk powder mixture gaining consistently. At time metabolism was determined was receiving 6 ounces of whole dry milk powder to 1 quart of water—7 ounces, boiled water 1 ounce. Getting orange juice irregularly. She was well rounded, firm flesh, and had two teeth.

Summary.—Normal, underweight infant, weighing 6.776 kilos. Expected weight, had she been at term, would be 8.23 kilos.

CASE 5: J. N., a male infant, $7\frac{1}{4}$ months old. Birth weight unknown. Always bottle fed. For first three months received a mixture of whole milk, water, and maltose; the next two months fed on a condensed milk mixture, and at 5 months on a mixture of whole dry milk powder. At this time was in a fair condition, perspiring freely, and had several boils. At time metabolism was determined he was receiving 5 ounces of dry milk powder to 32 ounces of water—5 ounces, water 2 ounces, condensed milk 2 teaspoonfuls—and also orange juice. Improved steadily.

Summary.—Of average normal development, weighing 7.854 kilos. Expected weight 7.98.

CASE 6: E. S., a male infant, 9 months old. Full term, instrumental delivery, always bottle fed. For the first three months fed on a grade A milk formula, but did not thrive. Then given a whole dry milk powder mixture and did well, but remained under weight for age. Two teeth. At time metabolism was determined was getting 6 ounces of whole dry milk powder to 1 quart of water, 2 tablespoonfuls of maltose—8 ounces every 3 hours, 6 feedings.

Summary.—A moderately underweight infant, flesh firm, but evidence of mild rickets, weighing 7.059 kilos. Expected weight 8.39.

CASE 7: H. C., a female infant, 8½ months old. Full term, normal labor, breast fed for one week; then given Nestle's food, was not satisfied, regurgitated, troubled with constipation, and had eczema. At 1½ months of age given a whole dry milk powder mixture and improved steadily. At time metabolism was determined she was receiving 6 ounces of whole dry milk powder, 47 ounces of water, and 4 tablespoonfuls of maltose—8 ounces every 3 hours, 6 feedings.

Summary.—Normal infant, weighing 9.072 kilos. Expected weight 8.175.

CASE 8: H. H. T., a male infant, 11¾ months. Full term, normal at birth, breast fed for one month. Then given grade A whole milk formula, but did not gain well. At 4 months of age was given a reconstructed dry milk mixture and improved steadily. At time metabolism was determined he was receiving an emulsified milk mixture and cereals. He had never had orange juice. Ten teeth.

Summary.—At 11¾ months weighed 8.618 kilos. Expected weight 9.43.

CASE 9: F. C., a female infant, 6 months old. Full term, Cæsarean birth. Partly breast and partly bottle fed up to date of metabolism determination, the minor part of the food said to be breast milk. Has always been well. At 2 months of age was given an emulsified milk mixture as follows: Reconstructed dry milk, 20 ounces; boiled water, 10 ounces; maltose, 2 level tablespoonfuls—6 ounces every 3 hours, 6 feedings. Receiving orange juice.

Summary.—At 6 months weighed 6.974 kilos. Expected weight, 7.27 kilos.

CASE 10: P. N., female infant, 6½ months old. Full term, normal delivery, breast fed for two months, and was then given a mixture of grade A milk, but did not do well. At 5 months was given 30 ounces of reconstructed milk, 12 ounces of boiled water, and 4 level tablespoonfuls of maltose—6 ounces every 3 hours, 7 feedings. Improved steadily. Was getting orange juice. Vaccinated 6 days before metabolism was done.

Summary.—At 6½ months weighed 7.087 kilos. Expected weight 7.499 kilos.

CASE 11: I. V., a female infant, age 3 months. Fed on a reconstructed milk mixture. Weight at 3 months, 4.337 kilos. Expected weight, 5.56 kilos.

CASE 12: C. C., a female infant, age 11½ months. Full term, normal delivery. Breast fed for 3 months. Then given a mixture of grade A milk. Was not sick, but did not gain well. At 7 months was put on a reconstructed milk mixture; improved, but did not gain very rapidly. At time metabolism was determined was receiving undiluted reconstructed milk, cereals, beef juice, and orange juice.

Summary.—At 11½ months weighed 7.272 kilos. Expected weight 9.373.

The following table gives the metabolism findings of these infants.

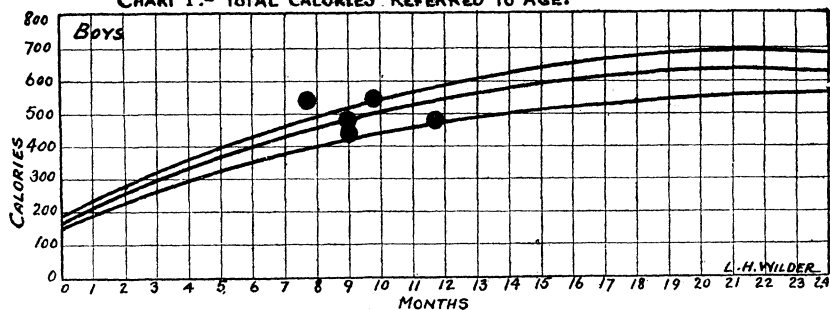
TABLE I.—*Metabolism findings of babies fed on dry milk powder.*

Case No.	Sex.	Age.	Height.	Weight.	Average weight for age.	Number of basal metabolism determinations.	Total calories.	Calories per kilo, body weight.	Calories per sq. m., body surface.	Pulse.
		<i>Mo.</i>	<i>Cm.</i>	<i>Kilos.</i>	<i>Kilos.</i>					
1	M	9	76	7.944	8.390	1	458	57.7	1,078	113
2	F	5½	72	7.895	7.054	2	513	65	1,220	118
3	M	9½	72	8.675	8.660	2	541.5	64.5	1,215.5	119
4	F	8½	67	6.776	8.230	2	421.5	61.5	1,124	103
5	M	7½	62.5	7.854	7.984	1	542	69	1,295	114.5
6	M	9	68	7.059	8.390	2	478	67.8	1,229	118
7	F	8½	71	9.072	8.150	1	579	63.8	1,236	108
8	M	11½	69.5	8.618	9.430	1	478	55.3	1,074	111
9	F	6	66	6.974	7.270	2	478	68.5	1,238	117
10	F	6½	.....	7.088	7.499	3	503	71	1,304	128
11	F	3	.....	4.337	5.560	2	288	66.4	1,074	118.5
12	F	11½	.....	7.272	9.373	3	559	73.3	1,405	114

Since none of these infants was more than 20 per cent below the expected weight for its age, they did not fall in the class of severe malnutrition or marasmus (see Talbot, *Severe Infantile Malnutrition*, American Journal Diseases of Children, 1921, 22, 358). The clinical impression was that this group of children were doing well, eight of the infants being within 10 per cent of the average weight for the age, and may be considered average normal infants.

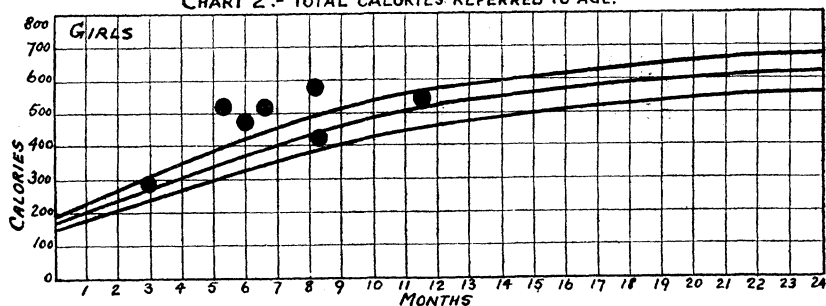
The accompanying charts show the distribution of the cases as compared to the normal standards. The heavy black line represents the average metabolism; the lines on either side represent the 10 per cent variation which may be considered normal.

CHART 1:- TOTAL CALORIES REFERRED TO AGE.



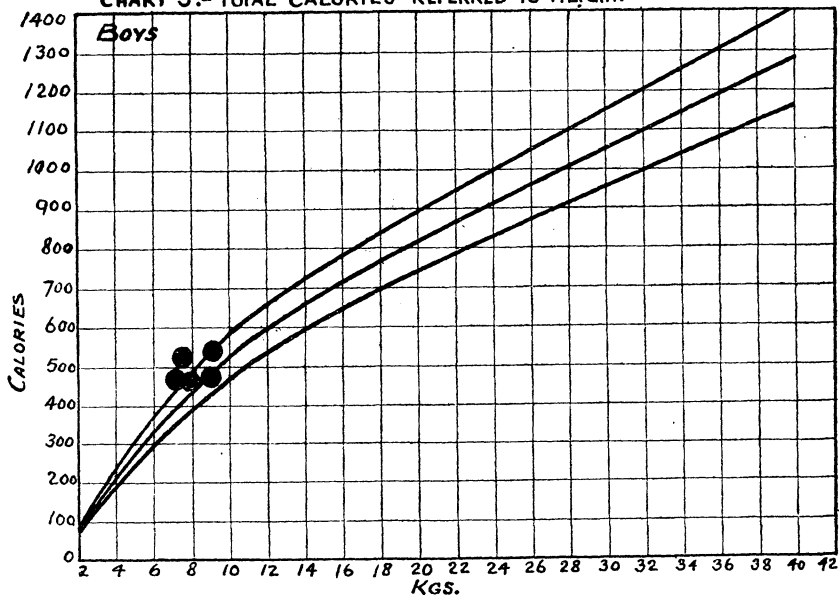
Basal metabolism of boys during first 24 months of age, showing the total calories per 24 hours.

CHART 2:- TOTAL CALORIES REFERRED TO AGE.

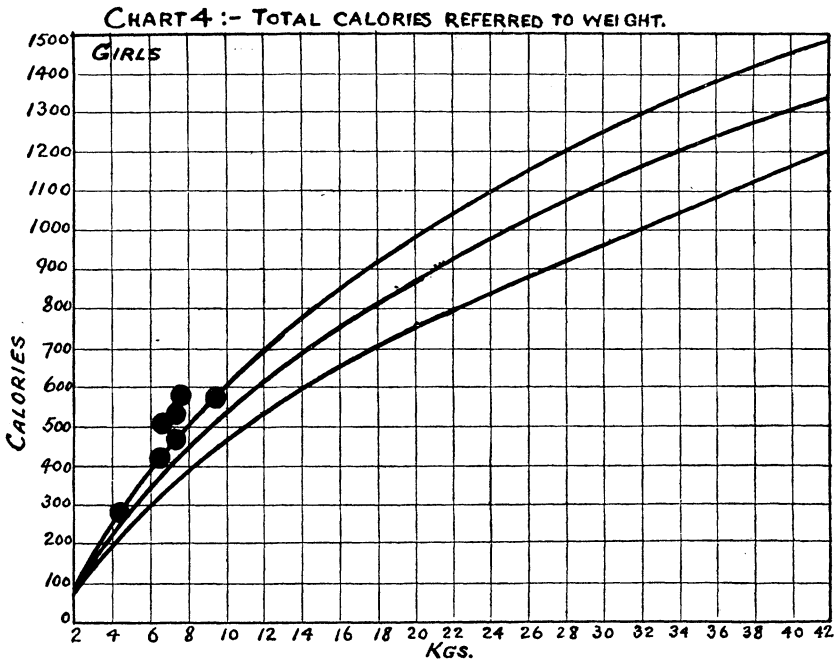


Basal metabolism of girls during first 24 months of age, showing the total calories per 24 hours.

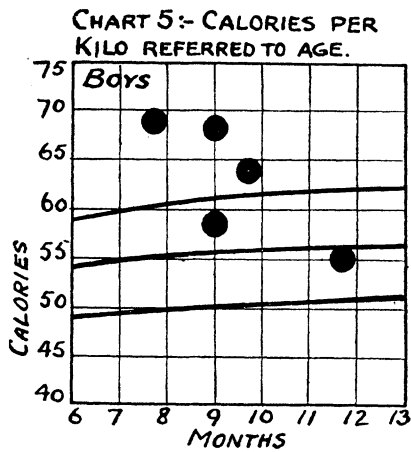
CHART 3:- TOTAL CALORIES REFERRED TO WEIGHT.



Basal metabolism of boys, showing total calories in 24 hours at different weights. The curve is projected from 32 kg. upward.

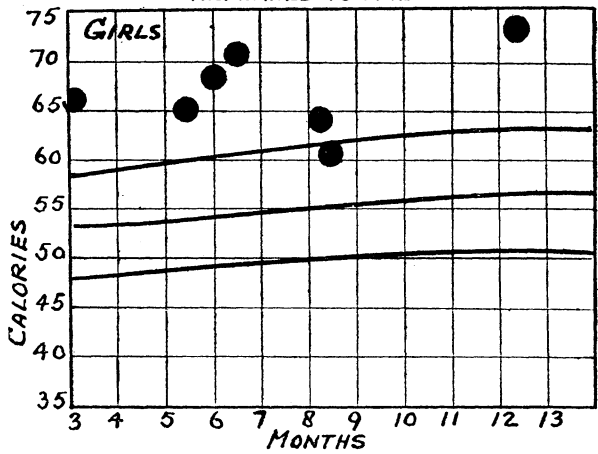


Basal metabolism of girls, showing total calories in 24 hours at different weights. The curve is projected from 32 kg. upward.

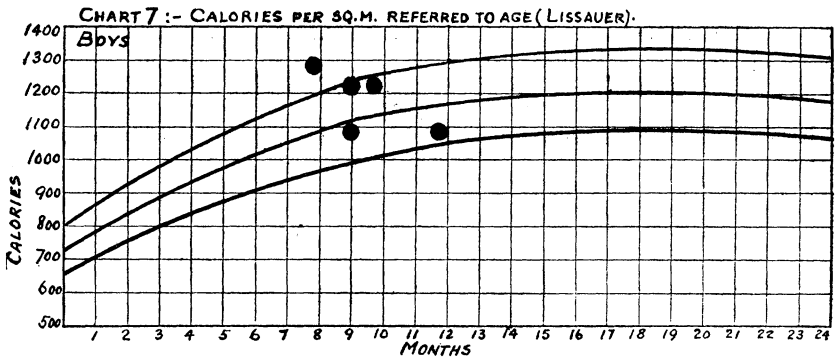


Basal metabolism of boys, showing calories per kilogram of body weight per 24 hours.

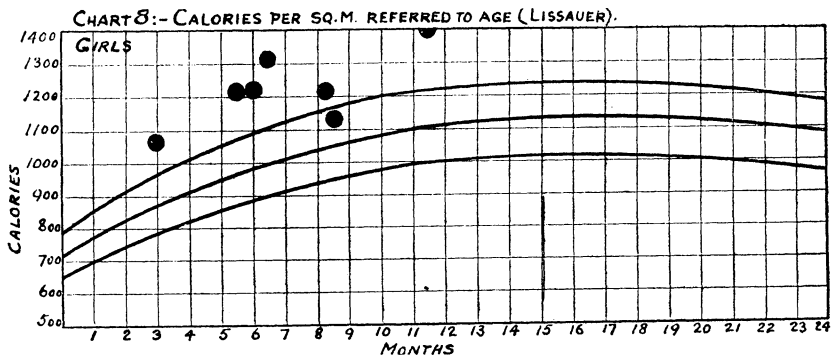
CHART 6 :- CALORIES PER KILO
REFERRED TO AGE.



Basal metabolism of girls, showing calories per kilogram of body weight per 24 hours.



Basal metabolism of boys, showing calories per square meter of body surface per 24 hours during first 24 months of age.



Basal metabolism of girls, showing calories per square meter of body surface per 24 hours during first 24 months of age.

SUMMARY.

The metabolism studies in this series of cases show a tendency for the boys to fall within, or very close to, the standard variations, the greatest deviation being in the calories per kilogram of body weight. The metabolism of the female infants, on the other hand, ran higher, and, with few exceptions, fell more than 10 per cent above the average, but are not outside of the extreme normal variation. This difference in the metabolism of the different sexes is in accord with what Benedict and Talbot² found in their series of observations; that is, that it was much more difficult to predict the metabolism of female than of male infants, and that the deviation from the average was much greater in the former than in the latter.

The results of the findings of this study on the basal metabolism of infants fed on dry milk powder show either a normal or a slight elevated "basal" metabolism. Coincident with most of the cases of an elevated metabolism, there was an elevation in temperature to 99° to 100° F.; but, as far as the writer has been able to determine, such slight elevations of temperature are not sufficient to explain the slight increase in the metabolism.

Case 11 had been vaccinated against smallpox six days previous to the metabolism determination. There is no published data on the effect of vaccination on the metabolism, but it seems reasonable to suppose that the metabolism would be more likely to increase on the tenth or twelfth day during the "take" rather than earlier.

All precautions were taken to insure quiet periods; and careful pulse and kymograph and visual records were kept of the infants during the metabolism periods to warrant recording the results as purely "basal" findings.

The basal metabolism of this series of infants fed on dry milk powder mixtures tends to be slightly higher than that of average normal infants, but is within normal limits. This may have been due to the relatively high protein content of the food, but the deviations from the average are not great enough to permit any striking conclusions to be drawn.

INFLUENZA IN ENGLAND AND GERMANY.

Official information relative to the occurrence of influenza in England, received by cable January 17, 1922, states that the disease is prevalent in several parts of England and is spreading. The epidemic period is short in each area affected, being from four to six weeks. The type of disease is stated to be of a much milder form than was that of the epidemic of 1918. Broncho-pneumonia is reported to be the chief complication.

²Benedict and Talbot: Carnegie Ins., Washington, Pub. No. 302.